

***A Different Approach
For
The Use Of Instrumentation
In
Icing Research & Certification Activities***

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Presented at the

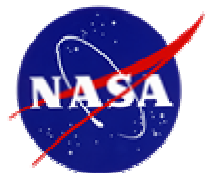
**FAA In-Flight Icing / Ground De-Icing International Conference
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Glenn Research Center

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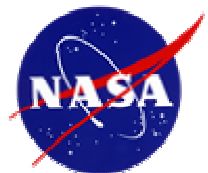
Page 1

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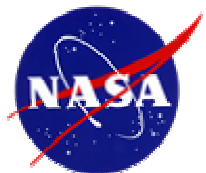
Objective

- To explore the aspects of a different approach to the use of cloud micro-physical instrumentation as applied in icing research and certification
 - Initially suggest idea
 - Receive comments back



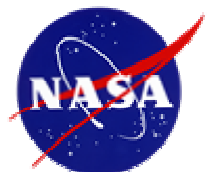
Outline

- Introduction
- The Issue
- A Simpler Approach
- Implementation Strategy
- Concluding Remarks



Introduction

- I have been involved in research activities where particle sizing and water content probes were used to characterize icing clouds
 - Icing flight research (SLD cloud characterization)
 - Icing tunnel (instrumentation assessment & other tests)
- This experience has led to some observations about the difficulties associated with inter-comparing icing cloud measurements
 - Between different instruments
 - When same instruments used in different icing wind tunnels



Introduction

This has caused me ponder the following question ...

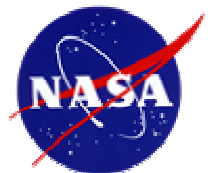
Is there a better way ... to apply this instrumentation to the measurement of icing clouds in

(1) icing research facilities

(2) natural icing conditions

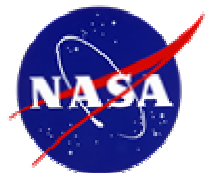
that better facilitates inter-comparison

and interpretation of the data from these sources?



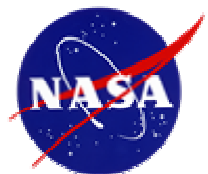
Observation

- It is difficult to inter-compare datasets having icing cloud measurements (LWC, Particle Size) obtained
 - With different instruments
 - In different icing tunnels
- Due to uncertainties introduced into measurements by
 - Different probe response characteristics
 - Different wind tunnel spray cloud characteristics



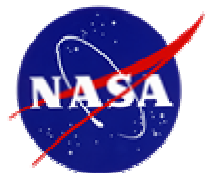
Observations

- These measurement uncertainties complicate attempts
 - To “pool” cloud micro-physical data into large datasets obtained from many different sources
 - To draw conclusions about trends from the “pooled” dataset
 - ♦ **Example: SLD Cloud Characterization Database**



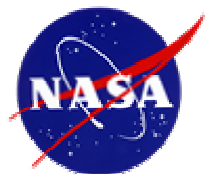
The Issue

- To accurately compare and interpret LWC and particle size measurements from two different datasets requires that
 - The unique response attributes of the instruments in each data set have been characterized
 - Translation function needed to account for differing instrument responses in each dataset
- This requires comparative testing of instruments which may be prohibitive in terms of cost, time, and resources



The Issue

- Additionally, it may impact the airworthiness authority who is called upon to review certification data
 - may not be an expert in cloud micro-physical instrumentation
- Yet they must try to interpret certification data associated with the specific icing cloud LWC and particle size measurements
 - Data from different sources (i.e. – tunnels, tankers, natural conditions)
 - Could be difficult to account for effect of icing condition uncertainty artifacts



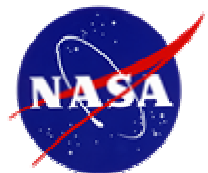
The Question Again!

Is there a better way ... to apply instrumentation to the measurement of icing clouds in

(1) icing research facilities

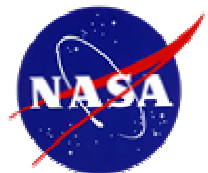
(2) natural icing conditions

that better facilitates inter-comparison and interpretation of the data from these sources?



A Simpler Approach!

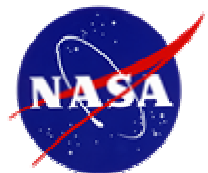
- Develop one instrument system which is used for tests conducted in certification activities (flight / tunnel)
- A cloud measurement system (CMS) having the capability to measure LWC and droplet sizing
- Thinking mainly in terms of certification, therefore lower fidelity needed than research instrumentation
 - But perhaps a higher fidelity system could be developed to meet research needs
 - An assessment of how good fidelity needs to be would determine system accuracy



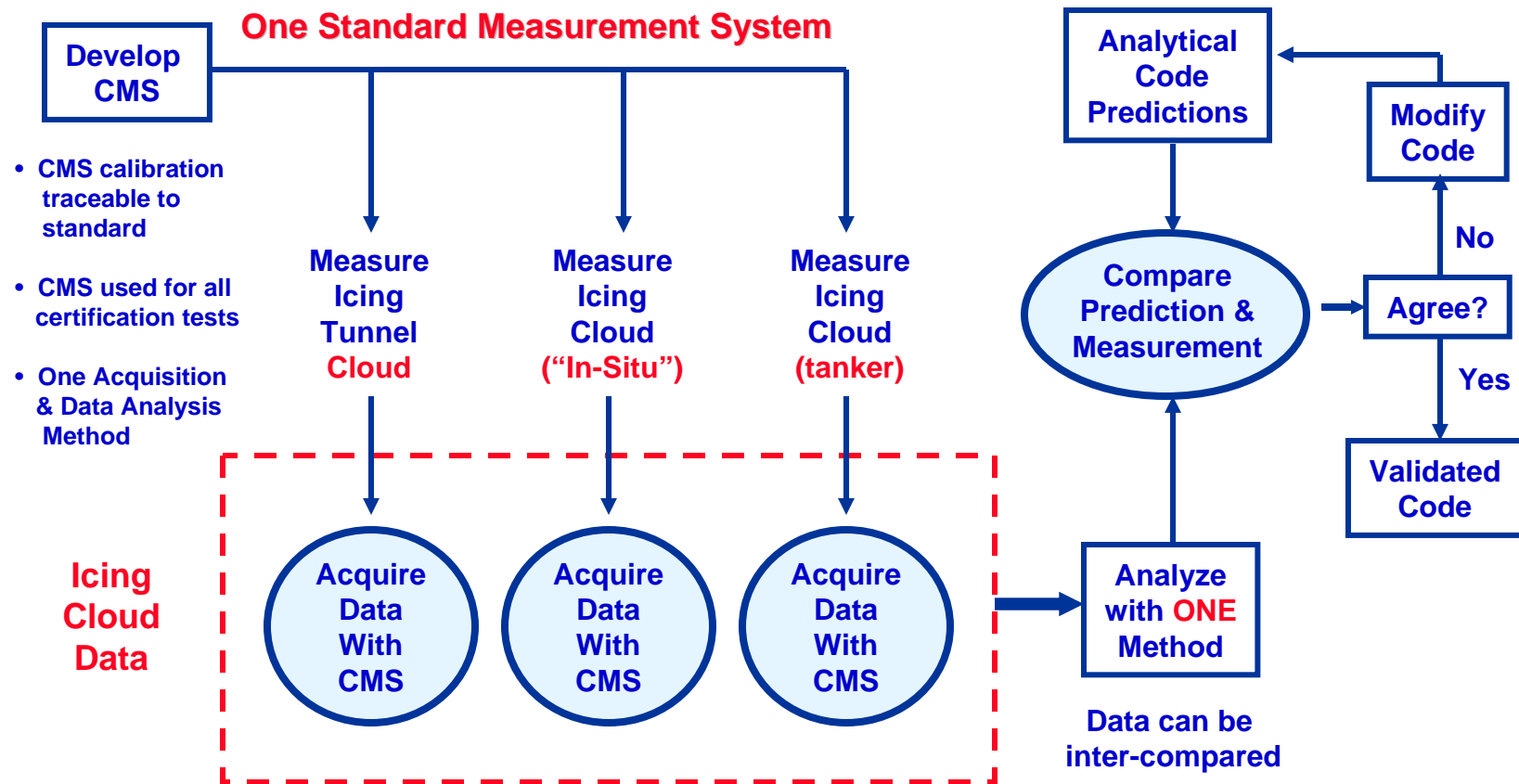
Benefits Of Simplified Approach

The benefits of this would be:

- One instrumentation package
- One analysis method
- Instrument response issues mitigated
- Facilitates comparison of different datasets on a common basis without need for an instrument response translation function



Cloud Measurement System (CMS) “The Common Thread”



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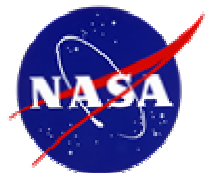
Page 13

at Lewis Field



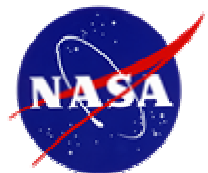
How Would This Be Implemented?

- Centralized facility established to oversee cloud instrumentation systems
 - **develop / maintain calibration standards & techniques**
 - **calibration of instrumentation suites**
- Centralized facility would have capability to provide a “traceable” calibration back to a higher fidelity suite of LWC and particle sizing instrumentation whose accuracy has been well documented
 - **MSC instrumentation suite (FSSP / 2Dg / 2Dp)**
 - **Other?**



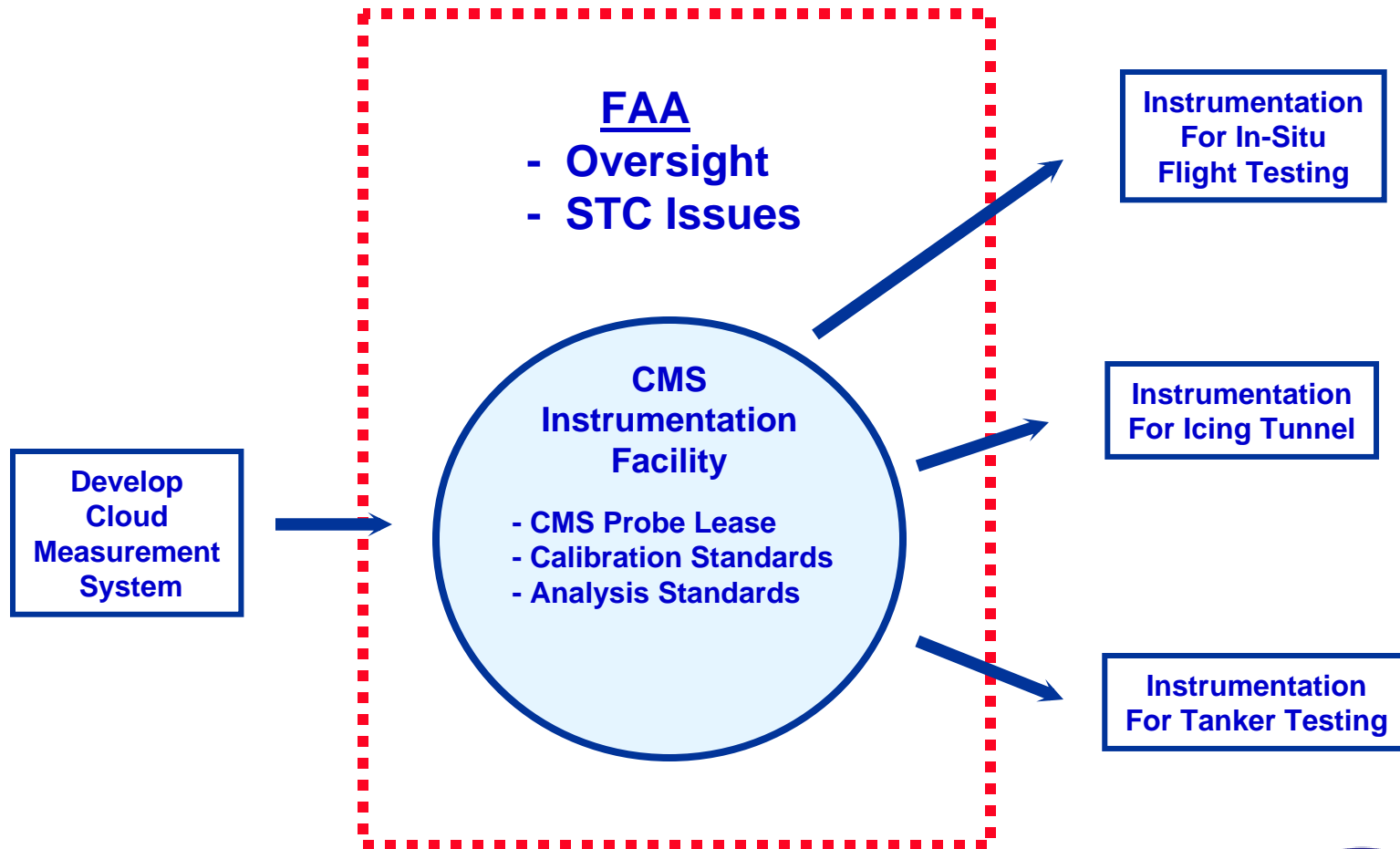
How Would This Be Implemented?

- Centralized facility would be a repository for measurement system packages which are leased to customers for compliance testing
 - **standard instrumentation package used to demonstrate compliance**
 - **use in natural icing / tunnel / tanker**
 - **standard calibration and analysis methods**
 - **STC of one package for customer airplanes**



Centralized Instrumentation Facility

One Measurement Method + One Data Analysis Method = Practical Solution



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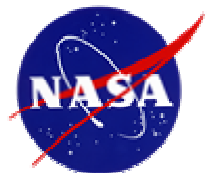
Page 16

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Benefits Of A Centralized Facility

- (1) Significant cost & steep learning curve associated with cloud physics instrumentation mitigated
- (2) Focused on one goal, providing good cloud measurements to support compliance activities
- (3) Ensure high-quality standardized measurements at a reasonable cost
- (4) Could provide capability to analyze data



Concluding Remarks

- There may be merit to “pooling” resources within the icing community to develop a single cloud measurement system (cms)
- The use of a single cloud measurement system has the potential to simplify inter-comparison of cloud physics measurements acquired
 - In different facilities
 - With different instruments
- Such a system could benefit both certification, and research activities

